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ABSTRACT

Previous research has demonstrated that requiring children to trace from memory the correct member of a pictorial discrimination pair markedly facilitates performance. The subjects for the first experiment in this study were 45 fifth grade students. The control group was given regular discrimination learning instructions. The image-trace group was told to note the correct item during feedback, and then with a picture of it in their minds, to turn their heads away and trace the outline of the picture in the air with their fingers. And the trace group was instructed to trace the outline of the correct item during feedback. The second experiment involved 63 kindergarten children and was based on an earlier observation that the ability to derive memorial benefits from self-generated imagery strategy seems to improve with age. On the basis of the evidence assembled in these experiments, it was concluded that copying a correct stimulus directly is not nearly as effective as is reconstructuring it from memory and that imagery rehearsal is a skill which is more sensitive to age differences than is verbal rehearsal. (TS)

Technical Report No. 352

# IMAGE TRACING: AN ANALYSIS OF ITS EFFECTIVENESS IN CHILDREN'S PICTORIAL DISCRIMINATION LEARNING

by

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Children's Learning and Development

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## ABSTRACT

Previous research has demonstrated that requiring children to trace from memory the correct member of a pictorial discrimination pair markedly facilitates performance. In two experiments reported here an analysis was made of the effective components of this learning strategy. On the basis of the evidence assembled it was concluded that the "memory image" component of the strategy appears to be important. Specification of the relationship of this "memory image" component to contemporary explanatory constructs such as "depth of processing" and "dual coding" awaits further research and analysis.

I

# INTRODUCTION

There is little doubt that children's verbal and pictorial discrimination learning can be greatly facilitated through appropriate rehearsal activity on the part of the subject. Recently reported was what is believed to be the most effective rehearsal strategy yet uncovered (Levin, Ghatala, DeRose, Wilder, & Norton, 1975). The strategy consists simply of instructing the child to note the "correct" item in each discrimination pair, turn his head away from it and, with his finger, trace the imagined outline of the item (or, in the case of verbal items, its object referent) in the air in front of him. This technique is so powerful that in some pilot research we were astounded to find that children can exhibit virtual one-trial learning of almost 50 verbal discrimination pairs!

Levin et al. (1975) assumed the tracing strategy to be facilitative because it activates certain relevant cognitive processes in the learner. In the case of verbal discrimination pairs, the tracing activity presumably assists the child in generating a memory image of the correct item's referent which in turn enhances test trial performance (see Levin et al., 1975). Preliminary data in support of this speculation were provided in Experiment 2 of Levin et al. In that experiment it was found that subjects who engaged in tracing activity directed toward the orthographic characteristics of the correct word in each pair (i.e., "writing out" the word in the air in front of them) did not benefit as much as those who engaged in tracing activity directed toward the correct word's referent (i.e., outlining its visual image). These findings with word pairs fit both the "concreteness" and "dual-coding" explanations offered by Paivio (1971), in that rehearsal activity devoid of any contact with the visual characteristics of the object referent would not be expected to be as beneficial as rehearsal activity accompanied by such contact.

In the case of pictorial discrimination pairs, the tracing strategy presumably requires the child to engage in constructive activity in order to reproduce the picture from memory. Although the activity demanded by the strategy with words is seemingly more complex (transformation of a stimulus from a verbal to a pictorial code and reproduction of the resulting resulting image) than with pictures (storage and reproduction of a pictorial stimulus), active construction of a visual stimulus from memory is assumed to be an essential ingredient of the strategy for both types of material.

Two experiments employing pictorial stimuli are reported here to test further implications of the "memory image" hypothesis. In Experiment 1, subjects utilized precisely the same image-tracing strategy in two conditions. However, one condition included the (assumed) necessary memory component while the other did not. In Experiment 2, benefiting from Piaget's theorizing about the development of memory imagery (e.g., Piaget & Inhelder, 1971) as well as from some subsequent corroborative evidence (e.g., Wolff, Levin, & Longobardi, 1972), we selected children at an age where the image-tracing strategy might be expected to diminish in effectiveness.

## II

## EXPERIMENT 1

In the Levin et al. (1975) study it was found that fifth and sixth grade students could discriminate picture pairs at better than 98 percent accuracy, on the average, when given an image-tracing strategy. This figure is compared to about an 83 percent average accuracy level in the absence of the strategy (cf. Levin et al., 1975, Experiments 1 and 3, with the difference being statistically significant in both cases). What is it about the image-trace strategy that makes it so effective? Is it that subjects are engaged in some relevant motor activity directed toward the correct picture, as suggested in the introduction; or is it that because of the nature of the instruction, subjects are required to hold an image of the correct picture in memory; or both? It has already been determined that memory imagery devoid of tracing activity is not as facilitative as the two combined for children of this age (Levin et al., 1975, Experiment 1). In this experiment we ask the question: Is tracing activity devoid of memory imagery as facilitative as the two combined for such children?

### METHOD

#### Subjects

The subjects were 45 fifth grade students from a semirural midwestern community. The subjects were randomly assigned in equal numbers to three experimental conditions, and were individually tested in a small private room located in the school building.

#### Design and Materials

A 36-pair pictorial discrimination list was constructed from 72 line drawings of common objects. The two pictures in each pair were approximately 2" x 3" (5.08 cm x 7.62 cm) in size, and were mounted side by side on 5" x 8" (12.70 cm x 20.32 cm) cardboard pages that were inserted into a looseleaf binder. The manner in which particular pictures were assigned to pairs was not random. Rather, half of the items were paired on the basis of their apparently greater perceptual similarity, a manipulation designed to make discriminations more difficult. However, since the effect of this manipulation was negligible in all conditions, it will not be considered further.

The correct item in each pair was randomly chosen and designated by a small star pasted beneath it. Right-left placement of the items for each of two anticipation trials was determined randomly, but in accordance with the following restrictions: the correct item appeared equally often on each side for each trial; and half of the correct items switched sides from one anticipation trial to the next. Order of pair placement within the list was random on each anticipation trial.

Three experimental conditions were included: Control, where subjects were given regular discrimination learning instructions (i.e., with no rehearsal strategy suggested); Image-Trace, consistent with the Levin et al. (1975) procedure, where each subject was told to note the correct item during feedback, and then with a picture of it in his mind to turn his head away and trace the outline of the picture in the air with his finger; and Trace, where the subject was instructed to trace the outline of the correct item during feedback (i.e., on top of the picture itself rather than from memory).

Procedure

In each condition, subjects were given two examples prior to the actual discrimination task. These were to clarify the nature of the task, as well as to give subjects in the two tracing conditions a feel for the rate which was to be employed throughout (5 secs.). During the actual task, two unstarred items appeared for 5 secs., followed by a 5-sec. feedback interval during which the two items appeared in their same spatial positions but with the correct item starred. During the feedback interval, subjects in the two tracing conditions performed their rehearsal activity. This alternating process continued for each of the 36 pairs. Following a 5-sec. blank interval, the second trial began. When each initial unstarred pair appeared, subjects designated their choice by pointing to the item that they thought was previously correct. Each pair was followed by feedback before the next unstarred pair appeared, as on the first trial. No rehearsal was demanded of subjects on the second trial, however.

## RESULTS AND DISCUSSION

The dependent variable consisted of the number of correct anticipations on the second trial (the test trial). As was true in the Levin et al. (1975) study, performance in the Image-Trace condition was extremely high, approaching ceiling (an average of 34.9 out of 36, or 97 percent). Performance in the two other conditions was not this high, with averages of 32.5 (90 percent) and 30.5 (85 percent) in the Trace and Control conditions respectively. Since the variation within conditions differed markedly--as a result of the artificially reduced variance in the Image-Trace condition (3.6), in comparison to that in the other two conditions (11.4 and 12.8)--the data were converted to ranks and nonparametric analyses were conducted.

Since it was of interest to assess the comparative performance of the Trace condition vis-à-vis the other two, this condition was designated as a "control" condition for Dunnett comparisons as applied to the average ranks.

With $\alpha = .05$ (one-tailed, since it was of interest to determine whether the Trace condition was worse than or equal to Image-Trace but better than or equal to Control) and an adjustment for tied ranks making the analysis more powerful (see Kirk, 1968), it was found that the mean rank of Image-Trace was significantly higher than that of Trace, whereas the mean ranks of Trace and Control did not differ significantly from each other. For those readers inclined to conduct a parametric test of the Trace vs. Control difference (since for those two conditions the common variance assumption was reasonable), the above nonsignificant difference conclusion is upheld; $t(28) = 1.53$, $p > .05$, one-tailed.

The results clearly suggest that copying the correct stimulus directly is not nearly as effective as is reconstructing it from memory. Indeed, 11 out of 15 subjects (73 percent) in the Image-Trace condition made at most one error on the discrimination task, in comparison to only 4 out of 15 subjects (27 percent) in the Trace condition. The superior performance of Image-Trace subjects may be surprising to those who hold that the more time spent in direct confrontation with a to-be-remembered stimulus, the better. On the other hand, it should come as no surprise to those of a "depth processing" (Craik & Lockhart, 1972) persuasion, where the degree of relevant semantic activity on the part of the subject is what is important--something which does not appear to be encouraged in the present Trace condition.

It is possible that tracing per se is facilitative, to some extent, but that its effect is too small to be detected with only 15 subjects per condition. However, even granting that such facilitation exists, it is likely due to the greater attention paid to the correct response (and less to the incorrect response) by Trace subjects, in comparison to the behavior of Control subjects. This speculation has some basis in fact, inasmuch as it has been found that eliminating the incorrect item during feedback improves performance (e.g., Ingison & Ekstrand, 1970) and that simple imitative rehearsal of the correct item substantially increases its subsequent recognizability (e.g., Wilder, Levin, Kuskowski, & Ghatala, 1974). Regardless of the precise explanation of simple imitative tracing effects, it was demonstrated here that tracing guided by a memory image is better. In Experiment 2, we re-examine the "memory image" argument from a different theoretical perspective.

III

## EXPERIMENT 2

This experiment was based on an earlier observation that the ability to derive memorial benefits from a self-generated imagery strategy seems to improve with age (see Levin, in press). If the observation is valid, then a prediction vis-à-vis the present task follows. Namely, if the image-tracing strategy indeed contains an imagery component, then it should be relatively less beneficial for younger children than for older children. In the Levin et al. (1975) study it was found that image-tracing and overt vocalization of the correct item were comparably effective pictorial discrimination learning strategies for fifth and sixth graders. Since the vocalization strategy is also known to be facilitative for younger children given the same task (e.g., Carmean, 1969; Wilder & Levin, 1973), it would be of interest to determine how young children would fare with image-tracing. A strong test of the present hypothesis would reveal little or no facilitation due to image-tracing; a weaker test would reveal that image-tracing had worsened in effectiveness in comparison to vocalization.

Consideration was given to the age of the subjects selected. It was desired to select subjects who would likely benefit from one strategy but not the other. Wilder and Levin (1973) noted that even nursery schoolers could successfully incorporate a vocalization strategy to improve their pictorial discrimination learning. On the other hand, in a paired-associate recognition task Wolff et al. (1972) observed that kindergartners did not benefit from an image-pantomime strategy somewhat analogous to the present image-tracing strategy. Consequently, kindergartners were chosen here.

### METHOD

#### Subjects

Sixty-three kindergarten children participated in the experiment. The children were drawn from two midwestern communities which could be characterized as above average in income and education. Equal numbers of subjects were assigned to the three experimental conditions.

#### Design and Materials

The construction of the 18 pictorial discrimination pairs were fashioned after Levin et al. (1975) and the present Experiment 1. The Control and Image-

Trace conditions corresponded to those in Experiment 1. In the Vocalization condition, subjects were required to pronounce aloud the name of the correct picture three times. The three-versus-one rehearsal difference in the Pronounce and Image-Trace conditions follows previous procedures (cf. Levin et al., 1975) and serves to equalize rehearsal times in the two conditions.

## Procedure

The testing procedures followed those of Experiment 1. However, since it was uncertain how well these younger children would perform, two anticipation test trials (rather than one) followed the initial study trial. On each trial, the pairs appeared in different random serial orders.

## RESULTS AND DISCUSSION

The dependent variable was the number of correct discriminations over the two test trials. The average performances (out of 36) were 25.0, 33.9, and 30.7 in the Control, Vocalization, and Image-Trace conditions respectively. As in Experiment 1, since it appeared that the variance was artificially constrained in one condition due to a ceiling effect (7.6 in the Vocalization condition) but not in the others (33.9 and 25.6 in the Control and Image-Trace conditions), the same nonparametric analysis was conducted as before. This time, however, Image-Trace served as the "control" condition for the Dunnett comparisons. According to this analysis ($\alpha$ = .05, one-tailed) it was found that the average rank of Image-Trace subjects was at the same time significantly lower than that of Vocalization subjects and significantly higher than that of Control subjects.

The results support the weak form of the hypothesis presented in the introduction to Experiment 2. That is, whereas children of kindergarten age are able to benefit to some extent from an image-tracing strategy in this task, they are not able to benefit as much from it as they are from a strategy that requires verbal rather than imagery rehearsal. On the other hand, with older children--specifically, with fifth and sixth graders--the two are equally effective pictorial discrimination learning strategies (Levin et al., 1975, Experiments 1 and 3). These results combined are consistent with the belief that image-tracing engages the visual imagery system to some degree, inasmuch as imagery rehearsal is a skill which has been found to be relatively more sensitive to age differences in comparison to verbal rehearsal (Levin, in press).

At the same time, one cannot discount the possibility that a subject's motor activity becomes more meaningful and differentiated with age. Obviously the two components (imagery and motor activity) are inseparable in the present context. It is similarly possible, following "production deficiency" arguments (e.g., Flavell, 1970), that overt verbal rehearsal contributes less to performance as the child develops, rather than imagery contributing more. However, this interpretation is not consistent with existing published (Carmean, 1969; Wilder & Levin, 1973) and unpublished data, where the effect of vocalization on pictorial discrimination learning is comparable in younger and older children.

Finally, the departure of the outcome from the strong form of the Experiment 2 hypothesis should be discussed further, as it is of potential theoretical importance. It will be recalled that if the present results were to parallel those obtained in the associative-learning paradigm, no facilitation due to image-tracing (the presumed analog to image-pantomiming) would be expected (cf. Wolff et al., 1972). Why, then, should we obtain facilitation with children of the same age in the present discrimination-learning paradigm?

Piaget and Inhelder (1971) have distinguised between two major types of visual imagery that emerge with development. Reproductive imagery, the more primitive of the two in that it is present in preoperational children, consists of simple imitations of previously represented objects and events. Anticipatory imagery, in contrast, does not emerge until the onset of operations (age seven or eight) and consists of novel transformations of previously represented stimuli. Since an effective associative-learning imagery strategy demands novel imaginal transformations involving the two stimuli (see Levin, in press), whereas the present discrimination-learning imagery strategy requires merely an imaginal reproduction of one of the stimuli, it is not surprising that presumably preoperational children should be able to cope with the latter though not the former strategy.

We wish to emphasize, however, that across-experiment conclusions such as these (where materials, subject populations, experimenters, and the like are bound to vary considerably) must remain speculations until more direct evidence is assembled concerning the different types of imagery assumed to be involved in associative- and discrimination-learning "imagery" strategies. It was previously noted, for example, that the present kindergartners were drawn from relatively well-to-do communities and were, therefore, likely to be developmentally advanced.

IV.

## GENERAL CONCLUSION

In the two experiments reported here, an effort was made to assess the components of a strategy previously found to facilitate children's pictorial discrimination learning. On the basis of the evidence assembled, a case was made for a "memory image" component. Although it would have been desirable to relate this component to contemporary explanatory constructs, such as "depth of processing" (Craik & Lockhart, 1972) and "dual coding" (Paivio, 1971), it seemed premature to do so here. Rather, a careful analysis must first be made of the similarities and differences in predictions associated with the various competing explanations. If it turns out that there are more differences than similarities, crucial experiments could then be designed.

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